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ABSTRACT

This examination of the open network architecture (ONA) concept and what can be expected as it is currently being implemented begins by defining the open architecture concept as the term is used in the communications and data processing fields. The marketplace benefits that flow from an open architecture are then summarized and the additional public policy benefits that could be achieved if ONA principles were applied to local exchange networks of the Bell Operating Companies (BOCs) are described. The Common ONA Model put forth by the BOCs is compared with the definition of a true open architecture, and it is concluded that the Common ONA Model represents a closed rather than an open architecture. Noting that this places the marketplace and regulatory expectations of ONA in doubt, it is argued that there is little incentive for the BOCs to embrace a true form of open architecture. Another policy option is recommended which suggests abandoning the idea of further unbundling of the local exchange network; instead, it calls for a legislatively mandated program for encouraging--rather than just permitting or, even worse, discouraging--competition in the provision of ordinary local exchange service. (GL)

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WHERE IS THE "A" IN ONA

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I. INTRODUCTION

Beginning in 1966, the Federal Communications Commission (FCC or the "Commission") has engaged in a series of proceedings dealing with policy issues brought about by the growing interdependence of communications and data processing. These proceedings are commonly referred to as Computer Inquiry I, Computer Inquiry II, and, the latest, Computer Inquiry III. In these proceedings, the FCC has, among other things, struggled with developing policies and rules under which regulated common carriers are allowed to provide unregulated enhanced or data processing-type services. The concern, of course, has been that telephone companies, such as the Bell Operating Companies (BOCs), would use their monopoly control over local exchange telephone service to cross-subsidize or discriminate in favor of their own enhanced service offerings.

In the two earlier proceedings, the Commission established and refined a concept called "maximum separation" in which carriers with monopoly power were required to establish separate, arms-length subsidiaries in order to offer enhanced services. The Commission defined maximum separation such that the competitive subsidiary had to be a distinct corporate entity with its own separate books of account, officers, operating personnel, equipment and facilities. These conditions and restrictions were intended to ensure that the subsidiaries did not unfairly benefit from their affiliation with the monopoly service provider. Collectively, these policies are often referred to as structural safeguards. It should be emphasized that the separate subsidiary requirements did not diminish the incentives for the monopoly carrier to cross-subsidize and discriminate; they simply made such behavior more difficult to accomplish and easier to detect.

In Computer Inquiry III, the Commission proposed to replace the structural requirements with certain non-structural safeguards. These non-structural safeguards included rules and procedures dealing with such things as the methods that BOCs use to allocate joint and common costs, the protection of Customer Proprietary Network Information (CPNI), and the disclosure of certain network interface information. The most important of these conditions, however, was that the BOCs unbundle their local exchange networks and offer the resulting basic service elements (BSEs) to all enhanced service providers -- including their own unseparated, enhanced service operations --on a tariffed, Comparably Efficient Interconnection (CEI) basis.

In Computer Inquiry III, the Commission, in effect, made the basic policy judgement that the public interest costs of the separate subsidiary obligations were outweighing the benefits that they produced in terms of protection against cross-subsidy

and discrimination. Three benefits are alleged to follow from replacing the structural obligations with non-structural safeguards. First, of course, the FCC expects that, when the BOCs are relieved of the alleged economic inefficiencies associated with structural separation, they will offer new, innovative enhanced services utilizing the unbundled local exchange network. Second, it expects unaffiliated enhanced service operators to utilize the unbundled basic building blocks (in combination with their own hardware and software) to offer new and innovative enhanced service offerings. Third, and finally, it expects the non-structural requirements to protect against discrimination on the part of the BOCs. In short, they expect the non-structural safeguards "to promote efficiency and competition, while preventing discrimination by these carriers, in the enhanced service marketplace."

The FCC's concept of unbundling and allowing all enhanced service providers to have access to the basic building blocks of the local exchange network on a tariffed, comparably efficient interconnection basis is called Open Network Architecture (ONA). Given (1) the past proclivities of the local exchange carriers to engage in anticompetitive activities, (2) the continued monopoly power of the BOCs in the local exchange market, and (3) the potential loosening of the Line of Business constraints in the Modification of Final Judgement (MFJ), it is obvious that there is a lot riding on the ONA concept. The purpose of this paper is to examine this notion of an Open Network Architecture and what can reasonably be expected of it as it is currently being implemented.

Thus the balance of the paper is divided into two sections. Section II which follows briefly describes an open architecture as the term is used in the communications and data processing fields. The marketplace benefits that flow from an open architecture are summarized and the additional public policy benefits that could be achieved if ONA principles are applied to local exchange networks of the BOCs are described. Finally, the Common ONA Model put forth by the BOCs is compared with the definition of a true open architecture. It is concluded that the Common ONA Model represents a closed rather than open architecture and, therefore, that the marketplace and regulatory expectations of ONA are in doubt. Section III argues that there is little incentive for the BOCs to embrace a true form of open architecture and, given that reality, another policy option is recommended. Basically, this option suggests abandoning the idea of further unbundling of the local exchange network. Instead, it calls for a legislatively mandated program for encouraging--rather than just permitting or, even worse, discouraging--competition in the provision of ordinary local exchange service.

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II. ARCHITECTURES, NETWORK ARCHITECTURES, AND OPEN NETWORK ARCHITECTURES

The term architecture is used extensively in the telecommunication and computer industries. Stated most simply, an architecture is the specification of relationships among various parts of a system. A network architecture, then, is an architecture that defines the various parts of a network and how these parts interconnect to accomplish the intended functions of the network. An open architecture is one that allows or even encourages the use of various vendors' hardware or software within the system. This is accomplished by organizing the system around natural building blocks or modules which are physically, electrically, and logically interconnected at well-defined interfaces. These interfaces use published, often industry standard, arrangements and protocols that lend themselves to widespread adoption. It follows that an open network architecture is a network whose natural modules or building blocks are unbundled and which employs accessible, well-defined, non-proprietary interfaces among the various modules.

There are significant advantages that flow from the adoption of an open architecture. For example, incremental improvements can be made in the system by changing out only one module or a set of modules rather than replacing the system as a whole. New products can easily be introduced into the system without the need for costly interface adapters or program modifications. In other words, the compatibility of new modules or building blocks is assured because of the well-specified interfaces. Moreover, modules with different performance characteristics can be introduced and the system reconfigured over time to meet changing requirements. Moreover, the system operator is not confined to dealing with a single vendor; instead, he or she can procure modules on a competitive basis.

A rather mundane example of an open architecture approach is a component-type high fidelity music system. A component type system might be comprised of say a compact disk (CD) player, a turntable, a preamplifier, an equalizer, an amplifier, and loud speakers. Because the system is modular and the interfaces are simple and easily specified, one can replace any one component--say the speakers -- without replacing the system as a whole. And, indeed, one can mix and match different brands and models of the components depending upon relative cost and performance factors. Perhaps the best known example of an open architecture in the computer world is the IBM Personal Computer. Because the architecture is well-specified, modular, open and non-proprietary, one can easily plug in a non-IBM hard disk card, a modem board, a FAX card or an accelerator board. Likewise, one can acquire a diversity of applications software from a myriad of

sources and have reasonable assurance that it will perform compatibly within the system.

In Computer Inquiry III, the Commission picked up on this idea and created the ONA concept as a regulatory tool. In their 1986 order in the proceeding the Commission stated:

> ...[W]e consider open network architecture to be the overall design of a carrier' basic network facilities and services to permit all users of the basic network, including the enhanced service operations of the carrier and its competitors, to interconnect to specific basic network functions and interfaces on an unbundled and 'equal access' basis. A carrier providing enhanced services through open network architecture must unbundle key network components of its basic services and offer them to the public under tariff. ... [s]uch unbundling will ensure that competitors of the carrier's enhanced service operations can develop enhanced services that utilize the carrier's network on an economical basis.

As noted earlier, by embracing the Open Network Architecture concept for the BOCs, the FCC hoped to encourage the development of the enhanced services industry and obtain protection against discrimination. However, in proposing to relieve the BOCs of the separate subsidiary requirements, the FCC did not actually tell the carriers how to unbundle their networks. Rather, in their Report and Order of June, 1986, they left it to the BOCs to work with the industry to develop ONA plans that reflected an open architecture approach. The BOCs filed their ONA plans with the Commission in February of 1988.

Although the plans filed by the individual BOCs differed in detail, they all employed a Common ONA Model that they had developed in conjunction with Bellcore. But the Common ONA Model destroys the very essence of the Open Network Architecture concept. It does so by introducing the concept of a Basic Service Arrangement (BSA). Under the Common ONA Model/BSA concept, there are four types of basic service arrangements that an enhanced service provider can obtain from the BOC: Circuit Switched Serving Arrangement, Packet Switched Serving Arrangement, Dedicated Serving Arrangements, and Dedicated Network Access Link Serving Arrangements. However, the circuit switched, packet switched, and dedicated BSAs consist of a bundled -- not unbundled -- package of the natural building blocks of the local exchange network: access (loops), central office features and functions (switching), and transport (interoffice usage).

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Under the Common ONA Model/Basic Service Arrangement construct, a Basic Service Element then becomes an optional network capability associated with a BSA. An example of a BSE in this construct would be the delivery of the calling party's telephone number or the provision of answer supervision. Thus an enhanced service provider or other user could not get a Basic Service Element without also getting a BSA and the BSAs themselves consist of bundled access, switching, and transport. Today, a customer buying ordinary telephone service or an interexchange carrier buying access service from the BOCs receives a bundled combination of access, switching, and transport. This means that the Common ONA Model/Basic Service Arrangement approach maintains the status quo as far as unbundling is concerned. It merely defines the fundamental building blocks to reflect the same degree of bundling that exists in today's local exchange offerings. Thus BSE's are not fundamental building blocks or natural modules at all; they are little more than enhancements to the custom calling features that are already available on modern stored program controlled central office switches.

There is another area of concern about unbundling as well. An important part of the genesis for the use of the Open Network Architecture idea as a regulatory tool came from the Intelligent Network concept or model. Without going into a lot of details, the Intelligent Network concept involves the unbundling of central office switches into two parts: the hardware and software portion that actually performs the basic switching functions and the portion that contains the software and associated hardware necessary to control the switching process. By unbundling the switching function in this manner and clearly defining the interface between the unbundled portions, the BOCs could more quickly and easily install advanced telecommunications services. Instead of relying entirely upon the switch vendor for the creation of new services, the BOC could write what amounts to their own "applications level" software or procure it on a competitive basis.

The Intelligent Network or IN concept was extended to include the possibility that Enhanced Service Providers could gain access to the local network and thereby create their own services. However, recent statements by Bellcore spokespersons and trade press accounts indicate that the IN concept is facing significant delays. Indeed, some important components were delayed for four years (from 1991) because some of the original goals were too ambitious.

Thus the situation seems to be as follows: There are at least four basic building blocks of the local network--access/loops, switching broken down into the two parts in

accordance with the IN model, and transport. Under the BSA concept, three of the four building blocks remain unbundled and, according to recent pronouncements by Bellcore, the fourth may not be feasible to unbundle, at least to the degree originally envisioned. Nevertheless, the Commission, in its decision late last year, explicitly approved the BOC BSA model and, with some requests for minor changes and clarifications, the actual ONA plans themselves. What they approved is not an open network architecture as that term is used in the communications and data processing industries. This failure to mandate true unbundling calls into question -- in the most fundamental way -- the very efficacy of the entire ONA effort.

With true unbundling of the local exchange network into the four basic building modules listed above, Enhanced Service Providers would have much greater leeway in creating new and different services. They would not be forced through bundling to buy modules they do not need or could provide more efficiently or effectively themselves. For example, they might use BOC local loops to reach their customers, but employ their own specialized switching equipment to route the associated traffic. Or they might use just the basic transport module of the BOC and their own switching and signaling to create an advanced metropolitan area network. In effect, true unbundling would tend to isolate the part of the network that is the real source of the BOC monopoly -- the local loop itself. True unbundling would enable the Enhanced Service Provider to pick and choose from a much wider range of basic building blocks and decrease the ability of the BOC to leverage its monopoly over the local loop into the adjacent areas of switching and transport. It would provide some protection against the BOC's pricing Basic Service Arrangements too high or refusing more efficient forms of interconnection until their own enhanced service operations are ready with a competitive response to a particularly innovative service offering.

In summary, it is clear that the Common ONA Model/Basic Service Arrangement construct put forth by the BOCs and approved by the Commission is a closed rather than an open architecture. Therefore the early -- almost euphoric -- marketplace and regulatory expectations of ONA are seriously in doubt.

III. A POLICY ALTERNATIVE

In its Memorandum Opinion and Order of December, 1988, the Commission noted that "more fundamental unbundling might be a socially desirable goal" and it did not foreclose further consideration of the issue at a later time. The BOCs, as one would suspect, were strongly opposed to true unbundling. Their arguments fell into four categories: First, it was argued on

procedural grounds that certain issues essential to a true open network architecture had already been decided. Second, it was argued that there were certain technical and operational difficulties inherent in further unbundling that made it infeasible at this time. Third, at least two BOCs were quite candid in arguing that further unbundling of the type described herein would facilitate Enhanced Service Providers competing with their own local exchange services. They argued that such competition would have a negative impact on universal service and presented complex problems of federal versus state jurisdiction.

The procedural objections to further unbundling can be put aside for the moment since they do not go to the policy merits of further unbundling. The arguments against further unbundling on the basis of technical and operational harms sound very much like the objections that were raised by the telephone industry to competition in terminal equipment and interexchange communications in the past. The idea of further unbundling the local network by unbundling and creating open interfaces for the loop, switching, and transport functions is not nearly as radical as it is painted in some quarters. Under the series of proceedings stemming from the original Carterphone decision, the Commission long ago unbundled Customer Premises Equipment and inside wiring from the rest of the network. The AT&T divestiture led to the separation of interLATA interexchange facilities and services from the balance of the network. All of these fundamental unbundling steps led to generally positive results for consumers. In fact, in the case of Customer Premises Equipment, the benefits far exceed what most policymakers originally foresaw and the dire predictions of economic and technical harm originally forecast by the telephone companies have not materialized.

With regard to the third group of arguments, further unbundling would, admittedly, facilitate competition in the provision of certain local exchange services just as unbundling customer premises equipment facilitated competition in that market. Indeed, it is the ability of the Enhanced Service Providers to efficiently substitute their own advanced switching, for example, that would stimulate the full development of new services and provide added protection against cross subsidization and discrimination by the BOCs. Competing Enhanced Service Providers would not be forced through bundling to buy basic building blocks of the local network that they do not need or that they could provide more efficiently or effectively themselves. Or stated another way, it would reduce the ability of the BOCs to discourage or control the development of competing enhanced services by virtue of their monopoly over the local loop.

If the local exchange network has natural monopoly characteristics, they probably stem from the local loop itself. Thus the idea of isolating the local loop bottleneck and allowing competition in the provision of switching (packet, circuit, and channel) and transport is simply a logical extension of a process of unbundling that is already well underway.

Nevertheless, the Commission has already decided to relieve the BOCs of the separate subsidiary requirement without mandating further unbundling. Moreover, because the BOCs have now gained what they originally sought -- the ability to provide enhanced services on an unseparated basis -- and because, as they readily admit, further unbundling would facilitate competition with both their monopoly local exchange services and their enhanced service operations, it is almost a foregone conclusion that they will fight vociferously against any further unbundling.

Given the realities of the situation, what are the possible policy options? If further unbundling to isolate and diminish the power that the BOCs exert by virtue of their control of the local loop is unlikely, then the best alternative may be to embark upon a policy of actually encouraging competition for the loop itself. The tool that the federal government has to encourage such a development is its control over the allocation of radio spectrum. Because of rapid advances in Radio Frequency (RF) devices and signal processing hardware and software, it is now possible to foresee the development of a radio based alternative to the local loop. Indeed, existing analog cellular systems are competitive on a cost and performance basis with fixed wireline systems in certain situations and, according to many observers and our own analyses, the advent of digital cellular systems will make them even more competitive. In addition, there is currently a significant amount of work going on in the United Kingdom and Europe to develop advanced cordless telephone or microcellular systems. Systems such as these could be readily adapted to the development of a competitive wireless loop network. There is even a possibility that these systems could be operated on a non-interference basis within existing cellular radio spectrum allocations.

Unfortunately, one half of the spectrum allocated to cellular radio has been given to the local telephone companies (wireline carriers) who have little incentive to compete with themselves. Furthermore, acquisitions of non-wireline cellular carriers by the BOCs and other local exchange carriers has produced the result that the wireline carriers now control all of the spectrum in many cities. This trend toward wireline ownership of the non-wireline carrier in many markets will be further exacerbated if the proposed merger of Lin Broadcasting's and Bell South's cellular operations is eventually consummated. Thus,

while cellular radio itself -- or a microcellular system operating compatibly within the existing cellular radio bands -- has the potential to offer real competition for the wireline loop, it is unlikely to happen given current ownership patterns.

Because it does appear feasible to establish a radio based alternative to the local loop, and because the existing spectrum that could perhaps be most logically used for such a system is already held by the BOCs or other telephone companies, I would urge the federal government to allocate radio spectrum for the specific purpose of facilitating competition for the local loop. Analyses carried out by our consulting firm indicate that the amount of spectrum required for such competition is relatively modest when a microcellular approach and advanced digital techniques are utilized.

One way of accomplishing this reallocation lies in legislation that is already pending in Congress. Congressman John Dingell, Chairman of the House Committee on Energy and Commerce, and Congressman Edward Markey, Chairman of that Committee's Subcommittee on Telecommunications and Finance, have recently introduced a bill calling for the reallocation of a substantial amount of spectrum from federal government use to commercial use. I recommend that this legislation, known as the "Emerging Telecommunications Technologies Act of 1989" (H.R. 2965), be modified to set aside some portion of that spectrum for the expressed purpose of establishing a competitive wireless local loop system. Furthermore, I would recommend that other efforts to free the BOCs from the Line of Business restrictions of the MFJ be held in abeyance until either (1) the rules and regulations necessary to facilitate the development of a wireless local loop service are established or (2) the BOCs agree to the kind of fundamental unbundling of the local exchange network that is advocated herein.

Of course, the Commission itself could also reallocate existing spectrum under its jurisdiction for the purpose of establishing a competitive wireless loop system. The advantages of doing it legislatively are (1) it would establish competition in the loop as national policy and (2) it could be a quid pro quo for legislatively lifting the line of business restrictions of the MFJ.

There are a number of substantial benefits that would flow from the establishment of new local exchange services based upon wireless loop technology. First, it would permit further deregulation of the BOCs and other local exchange carriers. For example, it would reduce the risks associated with extending price cap regulation to the local exchange carriers. Second, and on a related point, it would lessen the ability for the BOCs to

extend their monopoly over the local loop into adjacent competitive markets such as the market for enhanced services. Third, it would provide consumers with a competitive, low cost voice and low speed data service that would free them from being physically tied to the landline network. The incredible success of cellular radio and the widespread use of today's limited capability cordless telephones amply demonstrate the demand for such services. Fourth, it would provide a major new opportunity for existing U.S. manufacturers of radio system equipment. The United States still has at least two world class competitors in the radio market and establishing a wireless loop service would build on that strength. Fifth, the technological advances and economies of scale associated with the development of wireless loop systems would help extend low cost telephone service to rural and other isolated areas where fixed wireline service is infeasible or uneconomical.

Considering these benefits and the obvious difficulties of mandating true unbundling of the local network in the face of BOC opposition, I believe it is time to consider the option of encouraging competition in the provision of ordinary local exchange service. Fortunately, technological developments now suggest that such competition might well be economically feasible if a modest amount of spectrum is allocated to the purpose and existing regulatory barriers to entry are lifted.

I would like to acknowledge the assistance of my colleagues, Robert A. Mercer and Gene G. Ax, in the preparation of this paper. I would also like to thank Robert Crandall of Brookings for suggesting some of the benefits that might flow from an allocation of spectrum for local loop competition. However, the conclusions and recommendations of this paper are strictly my own and do not necessarily reflect the view of any institution with which I am affiliated.